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Assessment on the Impact of Variation Order on Project Performance in the Case of 40/60 Housing Project in Addis Ababa

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Approval Page

This Meng project entitled with "Assessment on the Impact of Variation Order on Project Performance in the Case of 40/60 Housing Project in Addis Ababa" has been approved by the following examiner in fulfillment of the requirement of the degree of Master of engineering in construction Technology and Management.

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Abstract

One of the major problems facing the construction project is issue of variation; during the construction phase. Variation orders impacted project performance with regard to cost and time overruns and disputes between parties to the contract. Most variation orders causes additional works. The complexity of works was the most predominant factor influencing the occurrence of variation orders. Client, contractors, consultant are the major causes of variation. Variations will have tremendous effect on the project performance as the negatively affect the productivity and cost. The reduction of the occurrence of variation orders was traced back to the pre-contract stage given that the most predominant origin agent of variation orders was the client and then due to an unclear brief of works to be executed. The aim of this paper is to discuss about the impact of variations order in the project performance in the case of 40/60 housing in Addis Ababa in order to take proactive measure to reduce them. The study indicates a cost overrun of 116.02% and 54.06% time overrun, the source of variation is the client and the causes of variation order is additional work order replacement of materials.

1 Introduction

Construction projects are among the most complicated of human enterprises. High levels of art and craft are required to translate an owner's vision into plans and specifications, then into real structures, one that fits the needs of the individuals and the public. In addition to technical skills, the ability to coordinate the diverse efforts of many individuals is crucial to success. (Girmay Kahssay, June 2003)

The nature of civil engineering projects makes them unique in that they are site specific and custom built. No standardized approach can be utilized in all cases. Each project is designed and executed in a specific location and under specific circumstances. This makes it difficult to tell ahead of time exactly how a project will turn out. In most cases, therefore, it is hard to tell exactly ahead of time what the final cost of a project will be. Consultants prepare design and tendering documents to the best of their knowledge and the available data. Contractors price their tenders on the available information included in the tender documents. (Aberra Bekele, July 2005)

The construction industry has special features that are not encountered in other industries. There is a wide range of operations and processes, more flexible and exposed for uncertainties than other industries. Thus the field organization must be adaptable to the varied conditions from project to project, and must be flexible enough to control adequately the works being executed under a multiplicity of site conditions. Furthermore, the planning and estimating of construction works must take into account these characteristics. Construction projects are therefore carefully planned and estimated so that they may be successfully completed with regard to quality, time, cost and satisfaction.

A construction contract is a business agreement that is subject to variability. Contractual clauses relating to changes allow parties involved in the contract to freely initiate variation orders within the ambit of the scope of the works without alteration of the original contract. Variation orders involve additions, omissions, alterations and substitutions in terms of quality, quantity and schedule of works.

Without contractual clauses, the building contractor would have to agree to erect the building shown on the drawings and represented in the bills for a contract sum. Any minor change that the

client or his/her architect wished to make later would mean that the contract had to be cancelled and a new one drawn up (Wainwright & Wood, 1983). Once a contract has been concluded, its terms cannot be changed unless the contract itself contains provisions for variation and then the only permitted variations are those that fall clearly within the contractual terms (Willis & Willis, 1980). Uff (2005) indicated that a clause permitting variation of works is an essential feature of any construction contract because without it the contractor is not bound to execute additional work or to make omissions or changes. Under contractual provisions, the client has the right to vary the extent and the nature of the performance to be rendered by the contractor (Wainwright & Wood, 1983). Furthermore, the contractor could not refuse to carry out the varied obligation with the only remedy being an adjustment of price to be paid for the performance, and in appropriate circumstances, an extension of time in which to execute such performance (Finsen, 2005). Ssegawa, Mfolwe, Makuke and Kutua (2002) argued that the spirit in which variation orders are permitted allows the contract to proceed without compiling another contract to cater for the changes.

Most contracts these days must make provisions for possible variations given the nature of building construction project (Finsen, 1999; Wainwright and Wood, 1983). An unfortunate aspect of the variation clause is that it tends to encourage clients to change their minds and embark on building projects without having properly thought through their project requirements (Finsen, 1999). Uff (2005) further pointed out that a clause permitting variation of works is an essential feature of any construction contract because without it the contractor is not bound to execute additional work or to make omissions or changes. It is the same for the architects, they tend not to crystallize their intentions on paper before the contract is signed because they know the variation clause will permit them to finalize their intentions during the term of the contract (Wainwright and Wood, 1983). Ashworth (2001) added that the advantage of the variation clause is that it allows the architect or other designers to delay making some decisions almost until the last possible moment.

This study investigates the Impact of Variation Orders on Project Performance in order to take proactive measure to reduce them. To achieve the study objectives, a critical review of relevant literature was done coupled with questionnaire survey to collect information on the impact of variations order in project performance with special emphasis on 40/60 housing building projects carried on Addis Ababa. A presentation of findings from questioner and discussion of the results

is included and finally the paper ends by summarizing some important conclusions and recommendations.

1.1. Statement of the Problem

Variation orders on construction projects have the potential to unnecessarily increase the cost and time of construction without adding value to the project in which case they may be regarded as waste, and the identification of their causes might lead to their reduction, possible elimination and subsequent improvement in overall project performance.

1.2. Objective

1.2.1 General Objective

- To investigate the impact of variation orders on project performance in order to take proactive measures to reduce them.

1.2.2 Specific Objective

- To investigate the prevalence of variation orders on construction projects;
- To identify the predominant origin agent as well as the direct causes of variation orders; and
- To establish the nature and extent of the impact of variation orders on overall project performance.

1.3. Research Questions

- What are the sources of variation in construction projects?
- What are the effects of variation on project performance?

1.4. Significance of the study

The findings of this research work are expected:

- To formulate the best practice approach in controlling variation;

- To provide recommendation towards reviewing and/or revising current contract documents, with a view to reducing variation order.
- To contribute towards the enhancement of project management skills in construction project, by analyzing past experiences;

1.5. Methodology

The methodology for carrying out the research work has focused on review of available literature on the topic of variation, published and unpublished variation related documents, and interview with project manager of the contractor involved in the Construction of 40/60 housing project in Addis Ababa. The problem investigated in this study is the impact of variation orders on 40/60 condominium building projects which were under execution in Addis Ababa. It is anticipated that the identification of the causes and source of variation orders may lead to their reduction, possible elimination and improvement in overall performance of public building projects.

1.5.1 The Study Approach

The methods of data collection impact the analyses, the results, conclusions, values and validity of the study at the end. From the theoretical point of view, qualitative approach seeks to gain insights and understanding people's perceptions of the world. This research can be both qualitative and quantitative. It is qualitative, because the study focused to obtain information about the cause, source and impact of variation orders from the project manager of the contractor perspective. Desk studies were conducted on specific 40/60 condominium building projects which were under execution in Addis Ababa. The desk studies on the selected sites involved the observation of project contract documents.

The study is also quantitative, because it focused on measurements of the variables that identified from the literatures to get answers for the formulated questions.

1.5.2 Data Collection

For a better understanding on the applicability of the various mechanisms used in assessing the impacts of variation orders, data was collected using desk study and Interview.

1.5.2.1 Desk study

In order to have information on the stated problem, data was extracted from the project original contract document and amended contract document. This helps to understand the relationship between the theories and actual practices in building projects. The data collected through the desk study was determined the worthiness of the topic for research.

1.5.2.2 Interviews

The interview was conducted face-to-face with the interviewee asking questions contractor project manager. Semi-structured interview were conducted with project manager to gather information on causes and impacts of variation orders on 40/60 condominium building projects which were under execution in Addis Ababa.

2 Literature Review

2.1 General

Housing is universally considered as the second, most important essential human need after food. The idea of condominium housing is a new phenomenon in Ethiopia. It is just as old as the IHDP. It emerged as a strategic response to rapid urban population growth, high prevalence of urban poverty, and urban unemployment in major Ethiopian cities; because only 30% of the urban house stock was regarded to be in fair condition; and the housing shortage is being estimated to be between 900 000 and 1,000,000 (MWUD, 2006, IHDP 2008).

A report published in 2004 indicated that there was a housing backlog of about 250,000 housing units in Addis Ababa alone (Addis Ababa Housing Development Project, 2004). The problem is exasperated by in order to alleviate the housing problem in the city by constructing condominium houses, the Addis Ababa city government has designed a Grand Housing Project in which redevelopment of the dilapidated inner city is given emphasis. The Housing Development Project Office and the Housing Agency were established to replace one-third of the inner-city dilapidated houses per year and transfer to residents at a subsidized rate. The main target groups are tenants residing in Kebele houses, which make up almost 90% of the inner city housing units.

Addis Ababa Saving House Development Enterprise start the construction of three different housing scheme 10/90, 20/80 and 40/60 projects in Addis Ababa starting from 2005E.C. From the three housing scheme 40/60 project is differ from other two by the amount of contract sum, contract period, the number of floor per block (B+G+8, B+G+10, 2B+G+13….), the number of household per floor etc.

According to The Ethiopian Herald, (27 Jan 2016) Currently, the construction of 36,160 houses in 380 block at 13 different site (Senga Tera, Crown, Ihili Nigid, Ihili Nigid 2, Hintsa Akirabi, Bole Bulbula 1, Meri Loqe, Bole Ayat, Tourist Nigid, Summit, Bole Beshale, Bole Hayat 2 and Bole Bulbula 2) are progressing. But until now the enterprise can't transfer the house to the people because they are lagging behind the schedule due to different reason. This paper try to see the impact of variation order on the project performance in 40/60 housing scheme.

2.2 Definition

There is no single definition of what constitutes a variation. Usually, any standard form of building contract will contain a definition of a variation in terms of specific actions and activities. Persatuan Akitek Malaysia standard form of contract (PAM 98) in clause 11, define variation as an alteration or modification of the design, quality or quantity of the works as shown in the contract drawings and described by or referred to in the contract bills.

According to Baker & Mc Kenzie (August 2013) the term 'variation' in the context of construction contracts can mean two things, namely:

(a) A 'variation' or change to the contract terms; and
(b) The narrower and well known meaning, that is, a physical 'variation' or change to the work (quantity or quality) required to be carried out under the contract.

Building Contract Dictionary third edition define Variations as alterations, additions or omissions in work, materials, working hours, work space, etc. And Variation order is an outdated term still commonly used to describe an architect's instruction (See: Instructions) requiring alterations, additions or omissions to the quality, quantity or design of the works.

The ever famous researcher in construction industry Prof. Vincent Powel-Smith describes the following meaning to the term Variation, any changes to the works as detailed or described in the contract documents …

As for PWD,203/203A(Rev.2007), condition of Contract clause 24.2, defines and stipulates the term "Variation" means a change in the contract Document which necessitates the alteration or modification of the design, quality or quantity of the works as described by or referred to therein and affects the contract sum including.

a) The addition, omission or substitution of any work
b) The alteration of the kind or standard of any of the materials, good to be used in the works, or the removal from the site of any work executed or materials or goods brought thereon by the contractor for the purposes of the work other than work, materials or goods which are not in accordance with his contract.

According to FIDIC 2006, MDB Harmonized Conditions of Contract for Construction March 2006 - General Conditions clause 1.1.6.9.

- "Variation" means any change to the Works, which is instructed or approved as a variation under Clause 13 [Variations and Adjustments].

And Under Public Procurement Agency (PPA) 2011, "Variation" is an instruction given by the Engineer, which varies the works.

2.3 Types of Variation

A contract can be varied in two ways that is Contract Variations or Variation in works. The latter is the one that most of us will think of when the terms that the parties had agreed and accepted when the contract was signed.

2.3.1 Contract variation

This deals with variation to the contract terms or conditions which referred to as an amendment to the contract. In other words, it is a change to the terms that the parties had agreed and accepted when the contract was signed. To vary the terms and conditions of a contract the same degree of formality is required as was the case with the original contract. It must be in writing, signed by the respective authorized party representatives, and in same form as the original contract. Normally variation to terms and conditions could occur under the following conditions: -

- Increased costs due to inflation or higher taxation.
- The varied work is not similar in charter or is not executed under similar conditions to that priced in the Bill of Quantities.
- Variation order renders contract rates or prices unreasonable in the opinion of the contractor.

2.3.2 Variation in Work

The more common understanding and indeed use of the term variation relates to a variation in the scope of works. Since the very concern of this paper is more focused on the variation in works

my evaluation and main part will elaborate with this respect. Under MDB Harmonized Edition March 2006, Variation in work is regulated and administered under Clause 13.1 Right to Vary.

In addition to this according to the PPA, January 2011 General Condition of Contract clause 15.1, the Contractor shall carry out all instruction of the Engineer, which comply with the Applicable laws where the site is located. Therefore, according to the Ethiopia applicable law,

- Civil Code Art 3031 - Alterations required by client.
- Civil Code Art 3034 - Alterations required by Contractor.

The contract will usually, but not always, provides a method that allows a client to make changes to the scope of works. By signing to this the contractor effectively consents to such changes being made. Accordingly, for building and Engineering works, the root causes of variation in works grouped under four categories: -

1. Owner related variations.
2. Consultant related variations.
3. Contractor related variations.
4. Other variations.

These groups assisted in developing a comprehensive enumeration of the potential causes of variations. Variation orders can be also classified in many different ways depending on the basis and the purpose of classifications. Referring both the reasons for their occurrence and subsequent effects, Arain and Pheng (2005) distinguisher and classified two types of variation orders, namely: beneficial and detrimental variation order. A beneficial variation order is one issued to improve the quality standard, reduce cost, schedule, or degree of difficulty in a project. A beneficial variation order eliminates unnecessary costs from a project as a result; it optimizes the client's benefits against the resource input by eliminating unnecessary costs. A detrimental variation order is one that negatively impacts the client's value or project performance (Arain and Pheng, (2005). For example, a client who is experiencing financial problems may require the substitution of quality standard or expensive materials to sub- standard or cheaper ones.

2.4 Origin and Causes of Variation Order

2.4.1 General

While variation orders are common in construction projects, an improved understanding would require their categorization into their root or origin agents and causes. The cognizance of origin agent consists of the identification of the initiator of the variation orders. A study that focused on the point of view of developers of potential causes of variation orders suggested four main origin agents of variation orders (Arain & Pheng, 2006). These included "owner", "consultant", "contractors" and "others". There is an interrelation between the origin agent and causes of variation orders.

2.4.2 Origin Agent

2.4.2.1 Client

The client as the project initiator plays a major role in the construction project from the inception to the completion phases. As a result, clients influence the likelihood of the occurrence of variation orders. Employer related changes are the causes of variations that were initiated by the client of the project. In some cases, the Employer directly initiates Variations or the Variations are required because the Employer fails to fulfill certain requirements for carrying out the project. The most common Employer related causes of variations are:

- **Change of plans or scope by Employer**

Change of plan or scope of project is one of the most significant causes of Variations in construction projects (CII, 1990b) and is usually the result of insufficient planning at the project planning stage, or also it can be because of lack of involvement of the Employer in the design phase (Arain et al., 2004). This cause the Variations affects the project severely during the later phases.

- **Change of schedule by Employer**

A change of schedule or master program during the project construction phase may result in major resource reallocation (Fisk, 1997; O'Brien, 1998). This is because time has an equivalent money value. A change in schedule means that the Contractor will either provide additional resources, or keep some resources idle in the construction site. In both cases additional cost is incurred.

- **Employer's financial problems**

The Employer of the project may run into difficult financial situations that force him to make changes in an attempt to reduce cost of the project. Employer's financial problems affect project progress and quality (Clough and Sears, 1994; O'Brien, 1998). Proper financial planning and review of project cash flow would be effective to avoid this problem from happening.

- **Inadequate project objectives**

Inadequate project objectives are one of the causes of Variations in construction projects (Ibbs and Allen, 1995). Due to inadequate project objectives, the designers would not be able to develop a comprehensive design which leads to many of Variations during the project construction phase.

- **Replacement of materials or procedures**

Replacement of materials or procedures may cause major Variations during the construction phase. The substitution of procedures includes Variations in application methods (Chappell and Willis, 1996). Therefore, an adjustment to the original contract value is required if there is a change in procedures.

- **Impediment in prompt decision making process**

Prompt decision making is an important factor for project success (Sanvido et al., 1992; Gray and Hughes, 2001). A delay in decision making may obstruct the progress of subsequent construction activities and that may eventually delay the entire project progress.

- **Change in specifications by owner**

Changes in specifications are frequent in construction projects with inadequate project objectives (O'Brien, 1998). In a multi-player environment like any construction project, change in specifications by the Employer during the construction phase may require major Variations and adjustments in project planning and procurement activities.

2.4.2.2 Consultant

Consultant related variations are the causes of Variations that were initiated by the consultant. In some cases, the consultant directly initiates Variations or the Variations are required because the consultant fails to fulfill certain requirements for carrying out the project. The changes initiate by consultant are as follows:

- **Change in design by Consultants**

Change in design for improvement by the Consultant is a norm in contemporary professional practice (Arain et al., 2004). The changes in design are frequent in projects where construction starts before the design is finalized (Fisk, 1997). Design changes can affect a project adversely depending on the timing of the occurrence of the changes.

- **Errors and omissions in design**

Errors and omissions in design are an important cause of project to delays (Arain et al., 2004). Design errors and omissions may lead to loss of productivity and delay in project schedule (Assaf et al., 1995). Hence, errors and omissions in design can affect a project adversely depending on the timing of the occurrence of the errors.

- **Conflicts between contract documents**

Conflict between contract documents can result in misinterpretation of the actual requirement of a project (CII, 1986a). To convey complete project scope for participants, the contract documents must be clear and straight to the point. Insufficient details in contract documents may adversely affect the project, leading to delay in project completion.

- **Inadequate scope of work for contractor**

In a multi-player environment like construction, the scope of work for all the players must be clear and without uncertainty for successful project completion (Fisk, 1997; Arain et al., 2004). Inadequate scope of work for the contractor can cause major Variations that may negatively affect the project, and leads to changes in construction planning.

- **Technology change**

Technology change is a potential cause of Variations in a project. Project planning should be flexible for accommodating new beneficial Variations (CII, 1994b). This is because the new technology can be beneficial in the project life cycle, for instance, reducing maintenance cost of the project. Or new methods of constructions that reduce construction cost.

- **Inadequate working drawing details**

To convey a complete concept of the project design, the working drawings must be clear and concise (Geok, 2002). Insufficient working drawing details can result in misinterpretation of the actual requirement of a project (Arain et al., 2004). Thorough reviewing of design details would assist in minimizing Variations.

- **Inadequate shop drawing details**

Shop drawings are usually developed for construction\ work details for site professionals (Cox and Hamilton, 1995). As mentioned earlier with regard to working drawing details, likewise, inadequacy of shop drawing details can be a potential cause of Variations in the construction projects.

2.4.2.3 Contractor

Contractor related variations are the causes of Variations that were related to the Contractor. In some cases, the contractor may suggest Variations to the project, or the Variations may be required because the contractor fails to fulfill certain requirements for carrying out the project. The changes initiate by contractor are:

- **Lack of Contractor's involvement in design**

Involvement of the Contractor in the design may assist in developing better designs by accommodating his creative and practical ideas (Arain et al., 2004). Lack of Contractor's involvement in design may eventually cause Variations. Practical ideas which are not accommodated during the design phase will eventually affect the project negatively.

- **Unavailability of equipment**

Unavailability of equipment is a procurement problem that can affect the project completion (O'Brien, 1998). Occasionally, the lack of equipment may cause major design Variations or adjustments to project scheduling to accommodate the replacement.

- **Unavailability of skills (shortage of skilled manpower)**

Skilled manpower is one of the major resources required for complex technological projects (Arain et al., 2004). Shortage of skilled manpower is more likely to occur in complex technological projects. This lack can be a cause for Variations that may delay the project's completion date.

- **Contractor's financial difficulties**

Construction is a labor intensive industry. Whether the Contractor has been paid or not, the wages of the worker must still be paid (Thomas and Napolitan, 1994). Contractor's financial difficulties may cause major Variations during a project, affecting its quality and progress and in some cases even the safety of the site is affected if there is an argument.

- **Defective workmanship**

Defective workmanship may lead to demolition and rework in construction projects (Fisk, 1997; O'Brien, 1998). Defective workmanship results in low quality in construction projects (Arain et al., 2004). Even the Contractor bares the cost of the defective work, but this also may affect the project negatively, leading to rework and delay in the project completion.

2.4.2.4 Situation beyond Control of Parties to the Contract

These refer to the causes of Variations that were not directly related to the main participants but caused by factors borne beyond the control of the main contracting parties. The familiar changes with regard to this category are:

- **Weather conditions**

Adverse weather conditions can affect outside activities in construction projects (Fisk, 1997; O'Brien, 1998). When weather conditions vary such as the various monsoon seasons in Malaysia, the contractor needs to adjust the construction schedule accordingly. Occasionally, this may affect the project progress negatively, leading to delays in construction.

- **Safety considerations**

Safety is an important factor for the successful completion of a building project (Clough and Sears, 1994). Noncompliance with safety requirements may cause major Variations in design. Lack of safety considerations may affect the project progress negatively, leading to serious accidents and delays in the project completion.

- **Change in government regulations**

Local authorities may have specific codes and regulations that need to be accommodated in the design (Arain et al., 2004). Change in government regulations during the project construction phase may cause major Variations in design and construction. This can affect a project negatively depending on the timing of the occurrence of the changes.

- **Change in economic conditions**

Economic conditions are one of the influential factors that may affect a construction project (Fisk, 1997). The economic situation of a country can affect the whole construction industry and its participants. Eventually, this may affect the project negatively, depending on the timing of the occurrence of the Variations.

- **Socio-cultural factors**

Professionals with different socio-cultural backgrounds may encounter problems due to different perceptions, and this may affect the working environment of the construction project (Arain et al., 2004). Lack of coordination is common between professionals with different socio-cultural backgrounds (O'Brien, 1998). Eventually, project delays may occur that end up with vital changes in the entire project team.

- **Unforeseen problems**

Unforeseen conditions are usually faced by professionals in the construction industry (Clough and Sears, 1994; O'Brien, 1998). If these conditions are not solved as soon as possible, they may cause major Variations in the construction projects. Eventually, this may affect the project negatively, leading to reworks and delays in the project completion.

2.5 Impact of Variation Order on Project Performance

2.5.1 General

Given a well-structured schedule of works, the maximum project performance could be achieved if the work progress flows smoothly within the time frame and within the budget. However, it is rare that a project performs according to the schedule due to several reasons such as market conditions changes and Variations on the design drawings or contract. Therefore, the occurrence of Variations has negative impact on project performance. Thomas et al (2002:144) believe that variability generally impedes project performance. Ibbs (1997:308) concluded that Variations have tremendous effect on the project performance as the negatively affect the productivity and cost. Arain & Pheng (2005:285) argued that Variations are unwanted but inevitable reality of any construction project. Hanna et al (2002:57) indicated that projects impacted by Variations causes the contractor to achieve lower productivity level than planned.

2.5.2 Cost Overrun

The most frequent and common effect of variation orders was the increase in project cost. It was not unexpected for the project cost to increase due to frequent variations in the project, as variation orders may affect the project's total direct and indirect costs. Therefore, any major addition or alteration in the design may eventually increase the project cost. In every construction project, a contingency sum is usually allocated to provide for possible variations in the project, while keeping the overall project cost intact. However, frequent major variations may lead to cost overrun in the contingency sum.

2.5.3 Time Overrun

Various authors agree that Variations could be one of the reasons behind project time overruns or delays (Chan & Yeong 1995:467, Mohamed 2001:1). It is said that a project that finished within the shortest time could, achieves some monetary savings. Unfortunately, each additional day due to occurrence of Variations on a project implies additional money. Variations issued during any various phases of construction gives negative affected to both project's completion time and cost increase (Koushki 2005:292). Hanna et al (2002:63) revealed that the more the Variations occurrence the more significant productivity losses. The productivity is the amount of output over a unit of time.

2.5.4 Addition payments for the contractor

Additional payments for the contractor can be a potential effect of Variations in construction projects. Variations are considered to be a common source of additional works for the Contractor. Due to additional payments, the Contractor looks forward to Variations in the construction project because contractor benefits from the additional profit on Variations.

2.5.5 Increase in Overhead Expense

Increase in overhead expense can be a potential effect of Variations in construction projects. This was because the process and implementation of variations in construction projects increased the overhead expenses for all the concerned participants.

2.5.6 Rework and Demolish

Rework and demolition are frequent occurrences due to Variations in construction projects (Clough and Sears, 1994). Variations which are imposed when construction is underway or even completed, usually lead to reworks and delays in project completion (CII, 1990a). Rework and demolition are potential effects of Variations in construction, depending on the timing of the occurrence of the Variations. These effects are to be expected due to Variations during the construction phase. This is because the Variations during the design phase do not require any rework or demolition on construction sites.

2.6 Controls for variation

Controls for variations and variation orders have been suggested by many researchers (Mokhtar et al., 2000; Ibbs et al., 2001). Discussed below are 30 controls identified from a literature review. These will also form the basis for the survey of the professionals later. The controls are grouped under three categories: Design stage control measure, Construction stage control measure and Design Construction interface stage control measure. These groups assisted in developing a comprehensive enumeration of potential controls for variation orders. The basis for the classification considers the anticipated time of the occurrence, the cause, and effect of the variation.

2.6.1 Design Stage Controls

The focus of this controlling measure mainly encompasses to avoid or reduce variations at the very beginning stage which may cause by design related, clarity of contract documents and lack of partnership from inception to implementation stage. By thorough reviewing contract documents and including balanced and comprehensive variation clauses, coordination and communication quality can be improved and conflict between contract documents and misunderstanding of the actual requirements can be avoided.

Involvement of different professionals at initial stage of the project; Owner's and Contractor's participation at the planning and scheduling process; and providing clear and thorough clarification about the project objective to all the participants are also effective variation controlling measures.

All these would assist in clarifying the project objectives and in identifying noncompliance with their requirements at an early stage. Eventually, this may help in eliminating the occurrence of variations during the construction stage where the impact of the variations can be more severe.

The most effective control of variations is team effort by owner, consultant and contractor. A delay in decision making may hamper subsequent construction activities that would ultimately delay the project progress. Hence, team effort by all participants would assist in reducing the adverse effects in the construction project. As mentioned earlier, coordination is important in a multi-participant environment as DBB construction projects. Variations, which affect the projects adversely, can usually be managed at an early stage with due conscientiousness in coordination. Construction projects are bound to encounter variation orders; the goal of any Owner, Designer, or Construction manager is to control the number and frequency of variations. Therefore, team effort by the participants would be helpful in reducing the adverse effects of variations when the project progresses.

2.6.2 Construction Stage Controls

When the occurrence of variation is required, a well-defined scope can assist the professional team in recognizing and planning appropriately to minimize the negative impact of the variation. It was observed that most disagreements between parties in a project site were about defining the variation scope. The original scope should be clear and well defined to distinguish between a variation of scope and a variation due to design development. Furthermore, managing a variation means being able to anticipate its effects and to control, or at least monitor the associated cost and schedule impact.

Any variation orders in the work shall be in writing, verbal agreements can be forgotten, and it must be approved by the owner before a variation order can be executed. Failure to do so may leave the contractor without any legal proof to get compensation for the variations. Clarity of variation order procedures is an integral part of effective management of variation orders (Mokhtar et al., 2000). During designing the contract documents, the procedures should be identified; rights and obligations shall be defined and made clear to all parties. Clarity of variation order procedures would help in reducing the processing time and disagreement between parties.

2.6.3 Design - Construction Interface Stage Controls

This phase is mostly called a final stage of the project. Since negotiation capability is an important factor for the effective control of variation orders, all professionals of the parties in a contract need to have ability to negotiate variations. Negotiation skill should not be underestimated since it comprises of the knowledge of contract terms, project details, technology, labor rates, equipment, methods and communication skills.

Consequential effects can occur later a project. Therefore, it is essential to acknowledge this possibility and establish the mechanism to evaluate its consequences. Professionals should thus evaluate the total overall effects a change may have on the final phases of a project, to manage the variation order effectively.

2.6.4 Value Engineering

The other most effective and potential controlling mechanism is that to develop and implement the concept of Value Engineering at the design phase. It emphasizes the application of an organized and systematic effort to analyze designed building features, systems, equipment, material selections, facilities, services and supplies for the purpose of achieving the intended functions at the lowest life cycle cost consistent with the required performance, quality, reliability, and safety. MDB-FIDIC General Conditions of Contract encourages the application of Value Engineering in clause 13.2 more elaborated manner.

2.7 Procedure and Valuation of Variation

2.7.1 Procedure of Variation

As previously indicated variation orders are typically issued in the form of contract instructions. The process of administering variation orders is shown on Figure 2.1 below. According to Ssegawa et al.(2002) contractual clauses state how variation orders should be initiated. In all cases, variation orders are issued by the consultant and must be given in writing or oral instruction should be subsequently confirmed in writing (Wainwright & Wood, 1983; FIDIC, 1999; Finsen, 2005; JBCC, 2005; Ssegawa et al., 2002). "Writing" includes drawings, faxes, e-mails, telegrams and

magnetic tapes and computer disks in which words and drawings may have been electronically recorded and are capable of being converted to text and drawings on paper or other similar media (Finsen, 2005). Since the contractor is not bound to comply with the oral instructions, all oral instructions have to be confirmed in writing by either the consultant or the contractor. Where variation orders are confirmed in writing by the contractor, the consultant has to confirm by signature. If the contractor is agreeable with the variation order, the works should proceed. The contractor and the consultant agree upon which method of valuation of variation orders should be used. The valuation of variation orders, while seen as an administrative step in the remuneration of changes effected to the contract, is in reality a rather complex matter involving a thorough understanding of contractual provisions, costing principles and an exercise of fair judgment on the part of the values (Harbans, 2003).

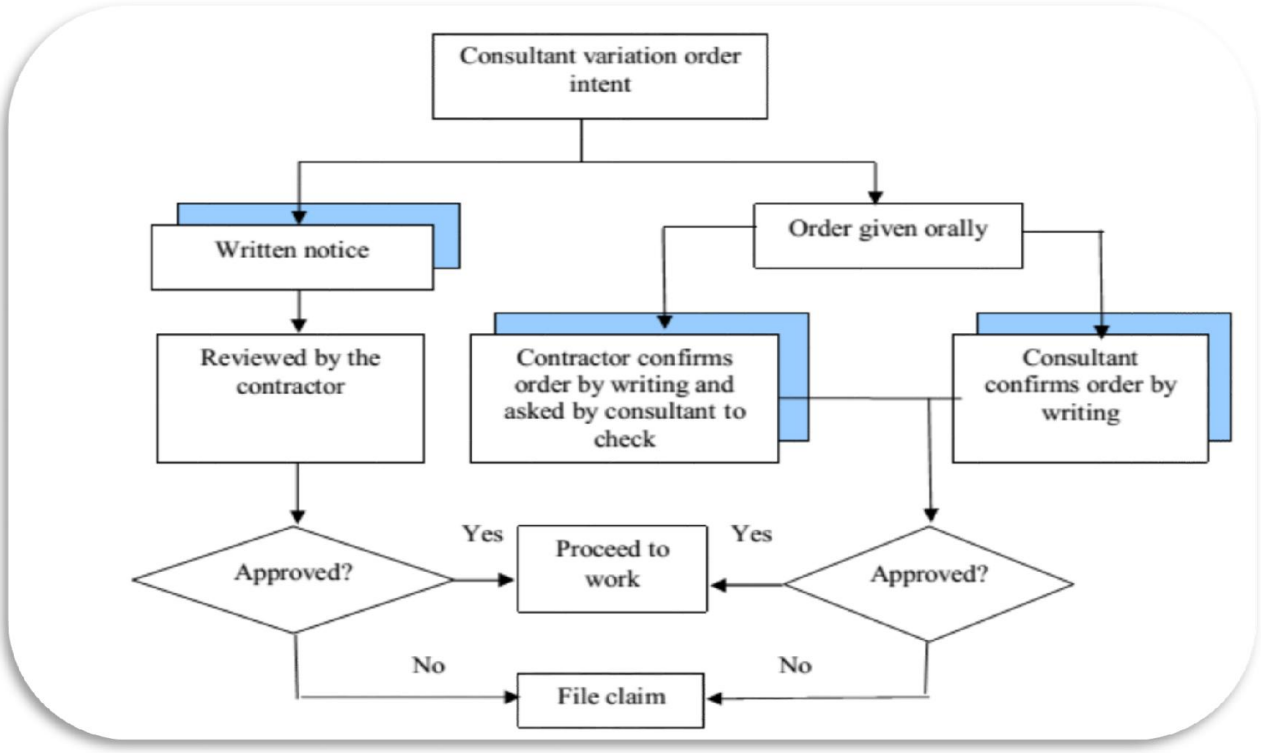

Figure 1: - Variation order process (Charoenngam *et al* (2003:200)

Under MDB FIDIC clause 13.3 the Procedure of Variation is clearly described beginning from how to instruct the variation order up to the evaluation process.

- The engineer instructs a variation

- The contractor acknowledges the receipt of it, and respond either starting why he can't do it, or provides details of how he will do it, interims of description of works, details of the program of works, details about the valuation of the variations
- The engineer responds by approving, disapproving or comment.
- The engineer evaluated the variations in accordance clause 12 (Measurement and Evaluation)

Under Ethiopia Public Procurement Agency, General Conditions of Contract stipulates under clause 15.2, "orders for variation must be given in written form to the contractor by the engineer within seven days of the request, the contractor shall provide the engineer with a quotation for carrying out the variation when requested." Finally, the engineer shall work the evaluation accordingly.

2.7.2 Valuation of Variation

The valuation of variation orders may be in the form of:

- Rates where contracted rates are adopted where the varied works are of similar character and extent and executed under similar conditions to items in the contract bills (Wainwright & Wood,1983; JBCC,2005);
- Day works which consist of the payment of executed works on a basis calculating the prime cost of works including materials, labor, plant hire and transport plus a percentage addition as agreed between parties to the contract (Harbans,2003);
- Quotation where contractors submit a quotation to effect the work contained in a variation order; and
- Quantum merit is a miscellaneous method where negotiated or agreed rates or payment are made on a reasonable sum (Harbans, 2003).

2.7.3 Method of Valuation of Variation

There are several ways to value variations, and different circumstances will require different method of valuation. Problems normally occur when there are different perceptions between the parties involved regarding the circumstances of the variations that require different methods of

valuations. Following the rules for variations provided in the form of contract, a contractor must bear in mind the possibilities of becoming involved in a contract that permits a wide range of variations and also that rates quoted in the bill of quantity, when considered appropriate, may be used for valuation of variations. The rule of valuation must be known in order to value variation. According to John Murdoch and Will Hughes (2000 edition) the following points are described as a rule:

- In relation to measurable work and omitted work any measurement is to be carried out in accordance with the same principle as those used for the preparation of the contract bills. The effect, therefore, is that all measurements taken to define the varied work must be taken in accordance with the relevant applicable laws.
- Allowance is to be made for any percentage or lump sum adjustment in contract bills such an allows is necessary because it is common practice for contractor when tendering to allow for overheads and profits by lump sum or percentage addition to the sum of preliminaries instead of allowing a proportion in each and every measure items. This provision allows the lump sum to be adjusted in line variation

An appropriate allowance to be made in respect of certain preliminary items, the use of which would not be attributable in whole to the varied items, but which would be needed in a different way if items where varied. For example, changing the way brick work is to be finished may involve keeping scaffolding on site for an extra period. The standard method of measurement contains further examples of preliminary items that may be affected in this way. Additionally, the above rule of valuation should not be implemented in a loss way, simply because the rate to which they are applied may not be appropriate. The rates and prices applied in the events of valuation should be the rate, which the contractor would have inserted against that item, had it been included at the time of tender. Differences in evaluating the applicability of the rate or prices from bill of quantity for valuation of variations have been demonstrated in several legal cases with varying result, the court decision to apply original prices or rates from bill of quantity had resulted in a significant loss of the contractor and vice versa. Variation works can be valued in to three categories in respect of John Murdoch and Will Hughes (2000 edition): work that can be valued by measurement, omitted work, and work that cannot be measured.

- **Measured work**: the basic rule applying to additional or substituted work which can properly be valued by measurement is that the rates and prices in the contract bills shall apply. However, this only applies to work of a similar character executed under similar conditions, which does not significantly change the quantity provided for in the bills. There is off course room for argument over exactly what is meant by such words as similar and character, nonetheless, most variation would be expected to fall within this principle.

  If the varied work is of a similar character to work already in the contract bills, but is executed under different condition or there is a significant change in the quantity, a different method of valuation must be used. Once again, the rates in the bills must be used as a base, but here the valuation must include affair allowance for the difference in quantities. The new rate which is thus derived from a bill rate by making this fair allowance is known as a star rate.

- **Omitted work**: here the bill rate can be and should be use for valuing the work omitted.

- **Immeasurable work**: in respect of additional or substituted work which cannot properly be valued by measurement, valuation may be on day works basis. It is important to note that a decision as to whether or not this method should be adopted is for the quantity surveyor to make; it is not for the contractor to insist on valuation according to day works.

Many standard forms of contract normally used for building adopt the bill of quantity for re-measurement. In the building industry the price is usually a lump sum, and the bills are intended to be simply a guide to allow the price to be determined. However, matters are not so simple, and provisions for the adjustment if there are errors in the bill of quantity makes the standard forms with quantities effectively re-measure. Briefly, all forms used the rates and prices in the bill as schedule of rates for valuation of variations.

Under the MDB FIDIC Clause 12, a proposed variation can be the subject of a quotation from the contractor either before or after it is instructed. If a quotation is not accepted an ordered variation can be valued in one of the following ways:

- Where the work is of similar character and carried out under similar conditions to work priced in the bill of quantities it shall be valued at such rates and prices contained therein as may be applicable'; or

- If no rates or prices are relevant for the derivation of a new rate or price, it shall be derived from the reasonable Cost of executing the work, together with profit, taking account of any other relevant matters.

In addition, if the effect of any variation is such that any rate in the contract is 'rendered unreasonable or inapplicable' the engineer can fix such rate as he thinks 'reasonable and proper'. This allows the engineer to look at the effect of any variation on the contract as a whole and to allow modification of other rates if necessary. Hence if a variation has the effect of extending the time to complete the works, any time-related or similar preliminary rates can be adjusted to allow for the consequence of instructing the change.

As per PPA general conditions of contract clause 15.5, All extra or additional work done or work omitted by order of the engineer shall be valued at the rates and prices set out in the contract if, in the opinion of the Engineer, the same shall be applicable. If the contract does not contain any rates or prices applicable to the extra or additional work, then suitable rates or prices shall be agreed upon between the engineer and the contractor. In the event of disagreement, the Engineer shall fix such rates or prices as shall, in his opinion.

3 Analysis

This chapter analyses the data collected using desk study and interviews. Interviews from selected respondents are presented, together with observations from desk study.

3.1 Analysis of Data from the Desk Study

During the study period, there were a total of thirteen (13) 40/60 condominium building projects which were under execution in Addis Ababa and four (4) project samples are taken for the study. From which variation orders approved were selected for desk study in order to fully understand the causes and impacts of variation orders and to determine what recommendations or strategies could be taken to minimize variation orders on public building projects. These projects were selected as a representative to the occurrences of variation orders of each of the 40/60 scheme of condominium building projects. The list of selected projects is as shown in Table 3.1.

Project Code	Project Name	Contract Amount(Birr)	Variation Order (Birr)	Percent of Variation Order (%)
Project A	Bole Ayat	17,924,326.89	22,108,988.03	123.35%
Project B	Sengatera	16,154,081.21	14,163,123.74	87.68%
Project C	Bole Ayat (Site2)	12,911,148.91	19,496,484.57	151.01%
Project D	Megenaga	19,288,472.95	21,125,060.77	109.52%

Table 3.1:- List of selected building projects

3.1.1 Project A

The tender sum for Project A was **17,924,326.89** Birr and the original planned works duration was **18 months**. There were numerous additional works associated with design changes due to owner's requirement. Due to this the number of floor increase from the original 2B+G+12 to 2B+G+13. And there was also an increase in the number of household per floor from six (6) to ten (10). Because of these changes a variation of **22,108,988.03 Birr** was ordered. As the contractor could not finish on the original agreed time, the extension of time of **12.33 months** to execute the change, was granted which was a time overrun of **68.50%** over the initial schedule of works. No penalties were levied against the contractor.

3.1.2 Project B

The tender sum for Project B was **16,154,081.21 Birr** and the original planned works duration was **18** months. A variation of **14,163,123.74 Birr** was ordered due to replacement of material. The client did not approve the variation at their earliest with the right decision due to this lack of decision making process by the client. The contractor was granted an extension of time of **8.9 months** which was a time overrun of **49.44 %** over the planned works duration.

3.1.3 Project C

Project C was awarded with a tender sum of **12,911,148.91 Birr** and the original planned works duration was **15.17 months**. The project was exposed to variation due to additional works order due to owner's requirement to increase the number of floor from the original 2B+G+9 to 2B+G+10 and increase the number of household per floor from six (6) to eight (8). Due to these changes a variation of **19,496,484.57 Birr** was ordered which was a cost overrun of **151.01%** and the contractor was granted an extension time of **7.93 months** which was a time overrun of **52.27%** over the planned works duration.

3.1.4 Project D

The tender sum for Project D was **19,288,472.95 Birr** and the original planned works duration was **18 months**. A variation of **21,125,060.77 Birr** was ordered due to additional works order by owner's requirement to increase the floor number by one which was a cost over of **109.52 %**. The number of floor increase from the original 2B+G+12 to 2B+G+13. And there was also an increase in the number of household per floor from six (6) to ten (10). The contractor was granted an extension of time of **8.23 months** which was a time overrun of **45.72%** over the planned works duration.

3.1.5 Findings from the Desk Study

The desk study was applied to two selected documents of 40/60 condominium building projects which were under execution in Addis Ababa contract documents. The contract documents were initial contract document, amended contract document, bill of quantities and drawings. The studied documents were signed, stamped and legal documents at law.

3.1.5.1 Causes and Sources of Variation Orders

The desk study findings showed that three (3) causes of variation and one source of variation order in answering the first objective. Below is the document study finding of summary of causes and source of variation orders from the four projects contract documents as shown in Table 3.2.

No.	Variation Orders	
	Causes	Source
1	Design change	Client
2	Additional Work Order	
3	Replacement of Material	

Table 3.2:- Causes of variation orders from the desk study

3.1.5.2 Impact of Variation Orders

From the document study findings, the following are summary of the impacts of objective.

No.	Impacts of Variation Orders
1	Increase in project cost
2	Completion schedule delay

Table 3.3:- Impacts of variation from the desk study

3.2 Analysis of Data from the Interview

These interviews were made between selected project manager of the contractor who are currently involved in the construction of 40/60 condominium building projects which were under execution in Addis Ababa public on their perceptions on variations orders. In total four interviews were conducted, with a selected contractor's project manager from the selected project site. First with a selected contractor's project manager from Bole Ayat (A), a selected contractor's project manager from senegatera (B) a selected contractor's project manager from Bole Ayat-site 2 (C) and a selected contractor's project manager from megenaga (D) as shown in Table 3.2 below.

The interview aimed at discovering the causes, source of variation orders and their impacts on 40/60 condominium building projects in Addis Ababa.

Questions	Interviewee A	Interviewee B	Interviewee C	Interviewee D
What are the causes of variation Orders on your Project?	*Design change *Additional Work Order	*Replacement of Material	*Design change *Additional Work Order	*Design change *Additional Work Order
What are the Sources of variation orders on your Project	*Client	*Client	*Client	*Client
What are the various impacts of variation orders on your project?	*Increase in project cost *Completion schedule delay	*Increase in project cost *Completion schedule delay	*Increase in project cost *Completion schedule delay	*Increase in project cost *Completion schedule delay

Table 3.4:- Interview results

3.2.1 Findings from the Interview

From the interview three (3) causes of variation orders were identified. The findings from the interview revealed that design changes, additional work and replacement of material were the causes which contribute to the occurrence of variation orders and the source of variation were the client in all projects. As identified from the interview, the impacts of variation orders which frequently occur on 40/60 condominium building projects in Addis Ababa were increase in project cost, most of the time which termed as cost overrun and completion schedule delay termed as time overrun.

4 Conclusions and Recommendations

4.1 Conclusions

As a conclusion, considering the fact that variations are common in all types of construction project, it is hoped that this research can be used as a guide by professionals to reduce and control variations in projects. Although variations are frequently unavoidable in the construction industry, 'unwanted' or negative variations are undesirable in projects as these would have an ad-verse impact on time and cost. The study also suggests that the management of variation must begin from the planning stage and continue through the end of the project.

4.2 Recommendations

Variations in the construction projects are familiar and common, though they vary in nature, size and effects. On the basis of this paper, the following potential recommendation are given.

- Since one of the most effective control of variations is team effort by owner, consultant and contractor. We recommend the use of Design-Build Project Delivery Systems.
  - ☞ Because in Design-Build the design & construction liability rests solely with the Contractor and contract administrator & quantity surveyor is done by the contractor itself; that is a single contractor provide the entire Construction Implementation Process (Design & Construction).
  - ☞ Thorough this reviewing contract documents and including balanced and comprehensive variation clauses, coordination and communication quality can be improved and conflict between contract documents and misunderstanding of the actual requirements can be avoided.
- Involvement of different professionals at initial stage of the project. Owner's and Contractor's participation at the planning and scheduling process; and providing clear and thorough clarification about the project objective to all the participants are also effective variation controlling measures. All these would assist in clarifying the project objectives and in identifying noncompliance with their requirements at an early stage.

- During designing the contract documents, the procedures should be identified; rights and obligations shall be defined and made clear to all parties. Clarity of variation order procedures would help in reducing the processing time and disagreement between parties.

- Since negotiation capability is an important factor for the effective control of variation orders, all professionals of the parties in a contract need to have ability to negotiate variations through continuous training on contract law and other similar courses.

- The criteria for the registration of consulting companies should be reviewed to reflect their technical capabilities.

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